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Identification of Misconceptions on Cell Concepts among Biology Teachers by Using CRI Method

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Abstract: This study aims (i) to assess the level of understanding and misconceptions of Biology teachers in Makassar regarding cell concepts, (ii) to identify the Basic Competence in which the teachers pose misconceptions, and (iii) to identify the factors cause misconceptions on cell concepts among biology teachers in Makassar. The study is a descriptive study which implements Certainty of Response Index (CRI) as the method to identify teachers' misconception. Participants of the study (n=22) were selected through purposive sampling based on the representativeness of the school in Makassar area. The result of data analysis showed that there were teachers who possess misconceptions (40.30%), scientifically accepted conceptions (49.10%), and transitional conceptions (10.77%). The misconceptions were found in 6 Basic competences of the cell concepts. The highest misconceptions (55.68%) was found on Basic Competence 3.2. which require participants to distinguish transport mechanism on the (diffusion, osmosis, active transport, endocytosis, and exocytosis) based on observation. There were several factors which cause the occurrence of misconceptions among the participants in this study, including low level of reasoning ability, low retention of knowledge obtained in undergraduate, lack of learning resources, incomprehensible terms, and low interest of Biology teachers on cell concepts.

1. Introduction

The ideal biology learning process is strongly influenced by the teacher's own perception of science and science learning. Teachers will be oriented towards learning based on their understanding of science and science learning. When teachers understand science as a product, their learning orientation will also focus on student mastery of science products. The products of science in question include facts, concepts, principles, laws, and theories. The learning process can be done in various ways but tends to ignore the true nature of science learning.[3]

The facts from the results of the research note that misconceptions in learners can be found when they enter the class for learning [12]. The misconceptions in science can be detected at various levels of education in all science concepts, both in the field of biology[14], physics [1], and chemistry [1]. As for the field of biology, there have been many studies that report misconceptions on several concepts such as the concept of vertebrates and invertebrates[13], the concept of cell structure and function [1], the concept of photosynthesis (Ekici (1995), the concept of transport and excretion systems[15], the

concept of diffusion and osmosis[5], the concept of genetics [1] the concept of protein synthesis[2] and on the concept of evolution [1].

Misconceptions possessed by learners can be obtained from the learning outcomes at the previous level of education. This is consistent with the study of Murni (2013) which explains that misconceptions obtained by someone from the previous education level will be retained up to college.

Another factor that causes misconception among learners is the teacher. This is explained in the research conducted by Taufiq (2012) that if the teacher taught the students the wrong concept, then this will cause wrong way of thinking for the students in their effort to reconstruct the knowledge, as there is interference between the concepts that had been studied (false) with the currently studied concepts (true). Misconceptions can also be permanent when it is not proven wrong or get challenged by another concept[12].

To identify misconceptions, one of the ways that can be used is the Certainty of Response Index (CRI) method. CRI is a diagnostic test consisting of multiple-choice questions or true-false questions with a combination of confidence on the truth of the chosen answer[4]. If a person's CRI score is low, then it indicates that the person is just guessing while answering. Meanwhile, if a person's CRI score is in a high category, it indicates that the person has a high level of confidence in choosing the answer[7].

Data of Teacher Competence Test results in Makassar city on November 2015 stated that the average value of Teacher Competency Test result in Makassar city is 53.4 or categorized as low category. Teacher Competency Test is a form of evaluation conducted to test pedagogic competence and professional competence of teachers[6]. The test portion tested based on LPPPTK report (2016) is 30% for pedagogic competence and 70% for professional competence. The large portion of professional competence in the implementation of the Teacher Competency Test and the low value obtained is the basis for the researcher to infer that there are misconceptions related to some concepts on the subject matter especially in the field of Biology. Another data that can be used by a researcher to examine misconception of Biology Teachers in Makassar is data from the Ministry of Education and Culture in 2015 which states that Makassar City is ranked 16th out of 25 regencies / cities in South Sulawesi in terms of the average of National Exam on biology lesson in academic year 2014/2015. Based on these data, it is necessary to take further action to know the description of misconceptions on cell concepts that happened to the Senior High Schools' biology teacher in Makassar City.

2. Method

This research was conducted at public Senior High Schools in Makassar City from August 2016 until March 2017. The participants of the research were 22 certified Biology teachers from 11 public high schools in Makassar City. The research instruments were in the form of multiple choice test to know the misconception of biology teacher and an interview guidance to obtain supporting data of misconception that happened to Biology teacher of Public Senior High Schools in Makassar City.

Data collection technique used in this research were interview technique (non-test) by using interview guide and measurement technique (test) by using diagnostic test instrument in the form of multiple choice questions with reason. Biology Teachers were asked to fill the level of confidence in the scale of 0 to 5 on the answers given to the questions and also to give the reason for their answer.

The test instrument has been developed by the researcher and had been tested for validity by two experts in the field of cell biology and evaluation. The instruments were then tested on different samples and then each item is analyzed with the ANATES V4 program to determine the validity, reliability, distinguishing and difficulty values. Data analysis techniques to identify misconceptions, scientifically accepted conceptions and transitional conceptions was the CRI method.

Table 1. Categories of Confidence in Answering by *Certainty Response Index* (CRI) Method.

Scale	Category	Percentage of guesses
0	*totally Guess the Answer*	100%
1	*Almost Guess*	75-99%
2	*Not Sure*	50-74%
3	*Sure*	25-49%
4	*Almost Certain*	1-24%
5	*Certain*	0%

Source: Hasan (1999)

Table 2. Criteria to distinguish between the idea of the concept, misconceptions, and did not know the concept of individual.

Answer Criteria	Low CRI (<2,5)	High CRI (> 2,5)
True Answer	The answer is true, but the low CRI means not knowing the concept	The correct answer and high CRI means mastering the concept well
Wrong Answer	The wrong answer and low CRI means not knowing the concept	The wrong answer but high CRI means misconception

Source: Hasan (1999)

Result

The results of data analysis on the conceptions of Biology Teachers in Makassar City on cell concepts using the CRI method can be seen in Figure 1. Based on Figure 1, it can be seen that there are 49.10% Biology Teachers in Makassar who posed scientifically accepted conceptions, 10.77% posed transitional conceptions, and 40.13% posed misconceptions regarding the concept of cells.

Figure 2 shows that the highest percentage of Biology Teachers who understand the concept of cell is the basic competence 4.1(XI) of 59.09% and the lowest percentage of Biology Teachers who understand the concept of cell is the basic competence 3.2 (XI) of 37.50%. Basic competence 4.1 (XI) required the ability to conduct microscopic analysis of onion cells and also human epithelial cell, to identify the organelles and its function. Meanwhile, basic competence 3.2 (XI) required the ability to compare transport mechanism (diffusion, osmosis, active transport, endocytosis, exocytosis) from observation. Based on the data analysis, it can be seen that the percentage of teachers who posed transitional conceptions is smaller than the other two levels of understanding on all basic competencies studied. While the highest percentage of misconception experienced by Biology Teachers in Makassar City is found in basic competence 2 of 55.68%.

The results also show that basic competence 3.1 (XI), 4.1(XI), and 3.1(XII) are basic competence with higher percentage of scientifically accepted conceptions than the other two levels of understanding (Figure 2). Basic competence 3.1 (XI) required the ability to explain the chemical component, structure, and function as the smallest unit of live, and also to identify cell's organelles from observation. Basic Competence 3.1. (XII) required the ability to describe growth and development process of living organisms along with the factors influence those processes. Good understanding of teachers on these materials is supported by high CRI values in answering the given problem, which means that the correct answers obtained are supported with a high degree of confidence on the answers.

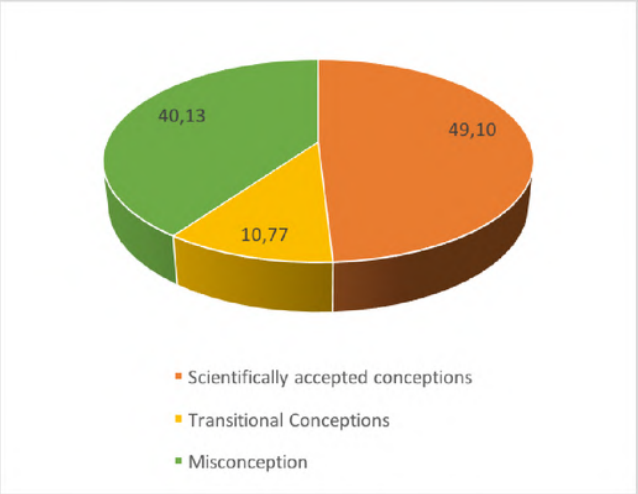

Figure 1. Average Level of Biology Teachers Conceptions in Makassar City Based on Diagnostic Test Results on Cell Concepts. (Source: Research Data 2017)

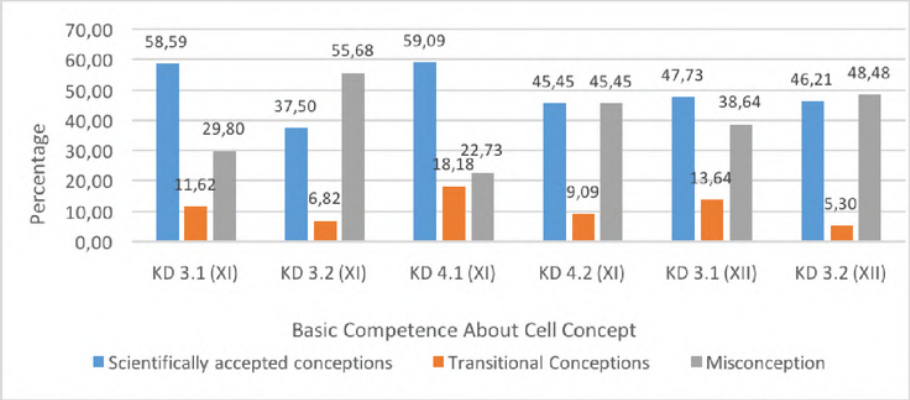

Figure 2. Level of Understanding of Biology Teachers in Makassar Based on Diagnostic Test Results on 6 Basic Competencies about Cell Concepts

The results of interviews with the four participants can be seen that their unfamiliarity in basic competence 4.1 (XI) on item number 10 can be caused by several things, among them: 1) There are two participants who teach in class XII Science so it is possible not to understand the concept of cells in basic competence number 3 as the basic competence is taught in class XI Science, 2) The four participants have never received special training on the concept of cell so that the lack of understanding about basic competence has occurred since long time back, 3) The retention of knowledge gained in college already decreased, so that the teachers cannot understand the concept, 4) The age of the teachers who are old causes the interest of self-learning to be reduced, 5) The source of

learning used by the teacher is only a textbook that the possibility of explanation of the concept is not sufficient so that teachers become unfamiliar with the concept.

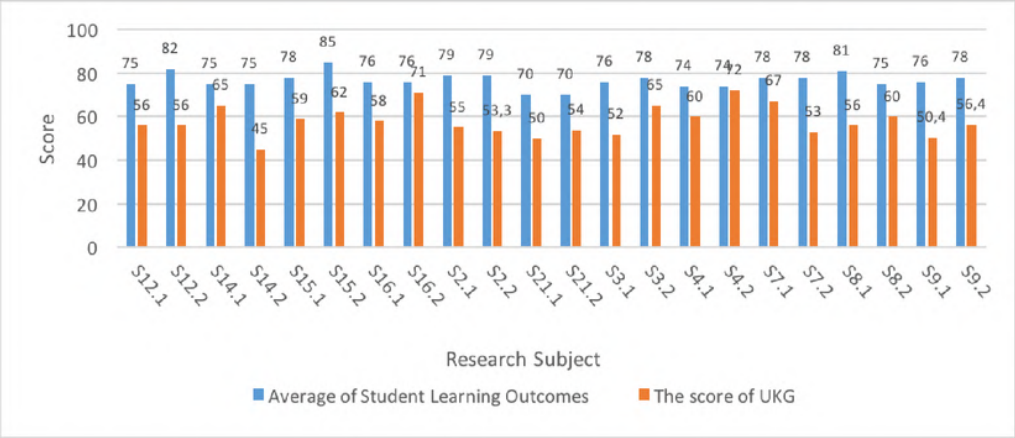

Figure 3. Average Learning Outcomes Students are taught by 22 Biology Teachers on Cell Concepts along with the results of teacher competency test results

The researcher identified several factors causing Biology teachers misconceptions on cell concept in Makassar City. The main factor that researchers can explain is the level of reasoning of Biology teachers in Makassar City on the concept of cells is low. This can be attributed to many things including the retention of knowledge that the Biology teacher has gained during his college years and the absence of periodic trainings obtained by the teacher on the subject of cell concepts. The lack of reasoning on the material learned can lead to misconceptions. The statement is supported by the results of research by Svandova (2014) which states that misconceptions may occur due to a lack of reasoning of a person to the material being studied[10].

Unique facts that researchers get is almost all teachers in the city of Makassar has a tendency to only teach at one level only course. For example, participants S4.2 and S9.1 who only teach in class XI Science more than 8 consecutive years, so for the material about the concept of cells in class XII Science becomes difficult for them. It can also lead to misconceptions due to the low retention of knowledge possessed by both participants. This pattern of teaching led to the lack of information obtained by the teacher because of lack of motivation to study the material of class XII science. As stated by Soeparno (2005) that the limitations of information is one cause of misconceptions.

Misconceptions of the Biology teachers in Makassar City were also caused by the lack of learning resources used by teachers. The results of interviews with teachers showed that almost all teachers only rely on printed books in schools as a source of learning. Few teachers use Campbell's book and Kimbal's book as a reading material for learning resources. The reason is because teachers need to read many times to understand the explanation of the book. The use of online media as a source of learning has been massively done by Biology teachers in Makassar, but none of the teachers claimed to have read a journal or a scientific article as a source of reading. This is in line with Soeparno's (2005) assertion that textbooks can be the source of misconceptions.

The material characteristics of cell concepts that contain many foreign terms, the explanations that require high reasoning ability primarily in metabolic material, cell division, and material transport across cell membranes also cause teachers' misconceptions. According to Hola (2004) teachers posed

misconceptions on biology subjects on all topics because Biology teachers have difficulty in integrating various science concepts.

Another factor that causes the lack of mastery of the field of knowledge by Biology Teachers in Makassar City is the lack of training on the concept of cells. Based on interview data, it can be known that the average of Biology Teachers in Makassar stated that they never participate in specific training about cell concept since they become Biology teacher. Training facilities to support training activities such as modules, or a collection of materials to help understand the concept of cells were never obtained. This can be seen from the books used as references by teachers that mostly still use the source of printed books in schools as a source of learning.

The tendency of textbooks in schools that contain material to be concise may cause teachers to have difficulty in understanding the concept of the cell as a whole. Inadequate learning resources can lead to misconceptions of the teacher. This is supported by Soeparno's (2005) assertion that text books can lead to misconceptions due to the book languages that are difficult to be understood[9].

The occurrence of misconceptions in Makassar City may indicate a decrease in the level of understanding of Biology Teachers in Makassar City on the material taught in this case on the cell concept. In line with that, Tahmir (2016) stated that the decline in teacher performance can be an impact of the decline in student achievement being taught[11].

4. Conclusion

It is concluded that the percentage of Biology teacher in Makassar City experiencing misconception, scientifically accepted conception and transitional conception on cell concept in 6 basic competencies studied were 40.13%, 49.10%, and 10.77%, respectively. Misconceptions of biology teachers in Makassar city were found in all basic competencies studied (Basic Competence number 1 -6). Basic competence number 2 is the basic competence with the highest misconception percentage (55.68%). The percentage of misconception on Basic Competence number 1 – 6 was 29.80%, 55.68%, 22.73%, 45.45%, 38.64%, and 48.48%, respectively.

Factors causing Biology teachers misconceptions on cell concepts in Makassar City were the low reasoning ability of biology teachers in Makassar City, the low retention of knowledge gained in college, the lack of learning resources that serve as a reference, difficult terms, as well as the teachers interest in studying the concepts of cells.

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